

PREPRODUCTION INITIATIVE HYBRID ELECTRIC TOW TRACTOR TEST PLAN

**SITES: MCAS MIRAMAR, CA
NAS BRUNSWICK, ME**

1.0 OBJECTIVE

This test plan describes the data collection procedure for evaluating the use of a hybrid electric tow tractor (HETT) in a Navy/Marine Corps operational environment. The data will also be used to determine the HETT's efficiency, effectiveness, and overall success with respect to performing the duties of a high-range tow tractor (A/S32A-37). The data will also be used to determine the environmental and cost benefits of using a hybrid electric or all-electric tow tractor rather than the diesel tow tractors currently used by the Navy/Marine Corps.

2.0 DESCRIPTION

The Navy/Marine Corps's current high-range tow tractor has a Cummins Model 6BTA5.9 inline, four-cycle diesel engine with turbocharger and aftercooler. These tow tractors are used to move large aircraft (such as C-130s and P-3s).

ISE Research Corporation (ISE) modified an Air Force MB-4 tow tractor to produce the HETT. The standard MB-4 is powered by a Cummins Model 6BT5.9 diesel engine, which was retained to provide backup power and charging for the HETT. Among other parts, ISE installed four ISE 600-V Thundervolt battery packs, a Fisher 80-kW AC generator, a Siemens PH224 electric motor, and appropriate controls.

The batteries can be charged manually by plugging the HETT into a receptacle. Alternatively, the batteries can be charged automatically by the auxiliary power unit (APU), which consists of the diesel engine, the Fisher generator, and a speed increaser (which regulates the output of the engine to an acceptable range for the generator). The electrical control system turns the engine on whenever the system voltage falls below approximately 550-V and turns it off after the batteries are charged to approximately 650-V.

The HETT has three steering modes: two-wheel (front wheels only), four-wheel coordinated (the front and rear wheels turn in opposite directions), and four-wheel oblique or "crab" (the front and rear wheels turn in the same direction). The four-wheel coordinated mode provides a smaller turning radius, and the crab mode permits the HETT to move diagonally.

3.0 TEST PLAN

This test plan will be used to evaluate the effectiveness of the HETT manufactured by ISE Research Corporation. Quantitative and qualitative data will be collected and used to evaluate the HETT's ability to safely and efficiently replace a conventional diesel powered tow tractor under typical Navy/Marine Corps operating conditions. Specifically, environmental and operating cost data (e.g., fuel consumption) and the performance of the electrical power supply system will be tracked during the implementation of this test plan. Calculations to determine the quantity of air emissions will be performed separately.

3.1 Approach

One HETT will be used during the implementation of this test plan. Between approximately April 2002 and September 2002, the HETT will be located at MCAS Miramar in Miramar, California. Between September 2002 and March 2003, the HETT will be located at NAS Brunswick in Brunswick, Maine. Quantitative and qualitative data will be collected by completion of the Operator's Log and the Monthly Maintenance and Repair Log.

At each test site, the HETT will be operated for two months in each of the following charging modes:

- APU: The HETT will be charged by the APU only. Please note, in APU charging mode the HETT must be plugged into grid power at least once per week in order to balance the battery system.
- Overnight: The HETT will be plugged into an electrical receptacle at the end of each day.
- Opportunity: The HETT will be plugged into an electrical receptacle as conditions permit during the course of the day.

3.2 Instructions for Completing the Operator's Log

Each HETT operator must complete their own Operator's Log. Up to seven moves can be recorded on each log sheet. Additional log sheets may be used as needed. For the purposes of completing the Operator's Log, when performing a single tow, a "move" consists of the following steps (see Figure 1):

- Transit to the aircraft/Support Equipment (SE)
- Hookup of the aircraft/SE to the HETT
- Towing
- Detaching the aircraft/SE from the HETT
- Transit back to the starting point.

When performing multiple tows, a single “move” shall be considered complete at the time the aircraft/SE is detached from the HETT (see Figure 2). The next move will commence with transit to the second item.

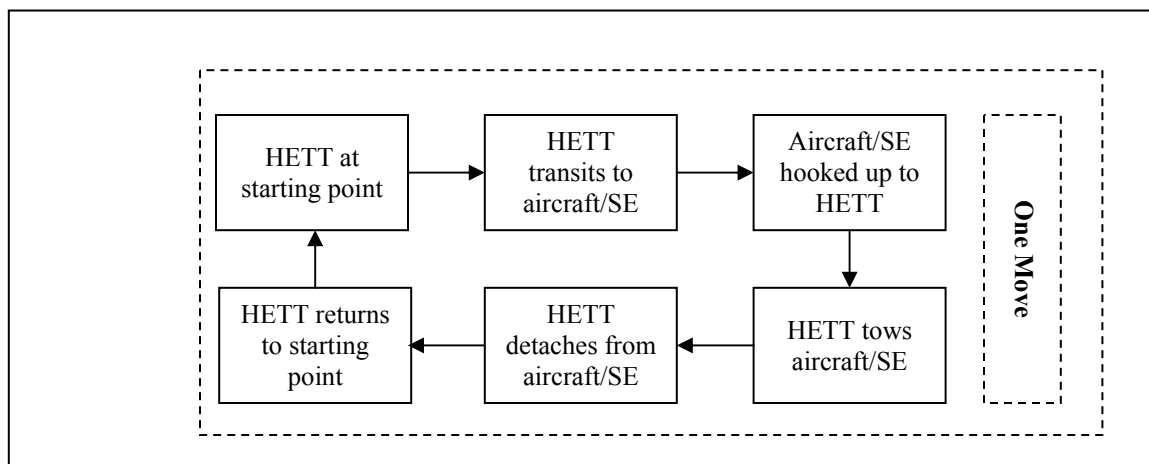


Figure 1. HETT Performs a Single Tow

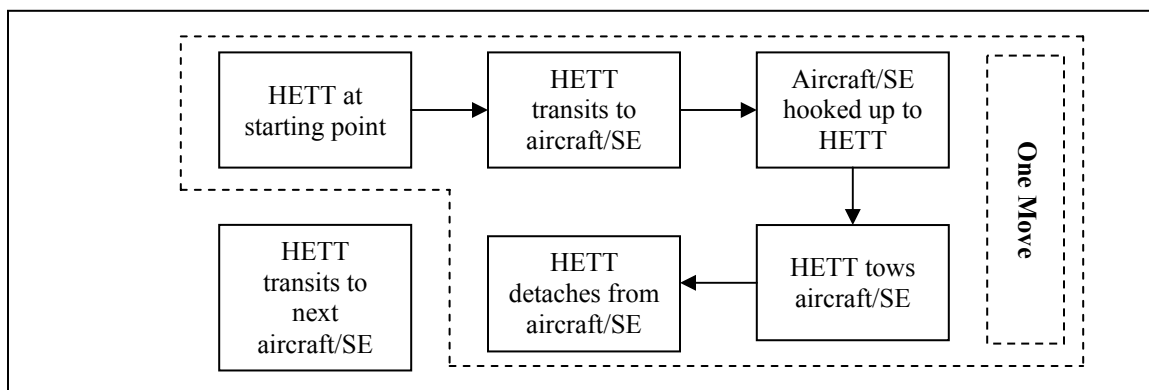


Figure 2. HETT Performs Multiple Tows

In cases where the HETT is used as a conveyance, record the odometer reading and the time at the start of the trip in the “Start of Move” columns and the odometer reading and the time at the end of the trip in the “End of Move” columns of Table 2. Place a dash in each of the other columns of Table 2.

3.2.1 Table 1: General Information

- *Squadron*: Enter the operator’s squadron.
- *Date*: Enter the date of use.
- *Temperatures*: Enter the shift’s expected high and low temperatures.
- *Charging Mode*: Check the box associated with the charging mode currently being tested (APU, Overnight, Opportunity).

- *APU Hourmeter*: The APU hourmeter is located at the bottom of the tachometer gauge (which is located in the upper left part of the instrument panel).
 - *At Start of Shift*: Enter the entire number (including tenths of hours).
 - *At End of Shift*: Enter the entire number (including tenths of hours).
- *Fuel Level*: The fuel level is indicated by a rectangular liquid crystal display located on the far left of the instrument panel. Each square represents one-eighth of a tank of fuel (2.25 gallons). The fuel level should be read when the HETT is level and stationary.
 - *At Start of Shift*: Enter the volume of fuel in the tank.
 - *At End of Shift*: Enter the volume of fuel in the tank.
 - *Total Quantity of Fuel Added During Shift*: Enter the volume of fuel added during the shift.

3.2.2 Table 2: Towing Data

- *Odometer at Start of Move*: The odometer is located at the bottom of the speedometer gauge (which is located to the right of the tachometer gauge). Enter the entire number, including tenths of a mile, that is shown on the odometer before beginning transit to the aircraft/SE to be moved.
- *Time at Start of Move*: Enter the time at which transit to the aircraft/SE begins.
- *Type of Aircraft/SE Towed*: Enter the type of aircraft/SE that is being towed. A record of the serial numbers is not necessary.
- *Time at Start of Tow*: Enter the time at which towing of the aircraft/SE begins. Note that this time should not be the same as the “Time of Arrival at Aircraft/SE”; the difference between these two times will be used to calculate hookup and other waiting times.
- *Time at End of Tow*: Enter the time at which towing of the aircraft/SE is complete.
- *Odometer at End of Move*: Enter the entire number, including tenths of a mile, as shown on the odometer once transit back to the starting point is complete or, if performing multiple tows, once the aircraft/SE is detached from the HETT.
- *Time at End of Move*: Enter the time at which transit back to the starting point is complete or, if performing multiple tows, once the aircraft/SE is detached from the HETT.
- *Steering Modes Used*: Check each appropriate box to indicate which steering modes were used during the move. Use “2W” for two-wheel steering (front wheels only), “4W” for four-wheel coordinated steering (front and rear wheels turn in opposite directions), and “C” for crab steering (front and rear wheels turn in the same direction). More than one steering mode may be used during a single move.
- *Operator’s Initials*: Enter the initials of the operator in the space provided.
- *Comments*: Provide comments regarding the advantages and disadvantages of the HETT compared to a standard high-range tow tractor. Also indicate if any problem areas or discrepancies were identified during use of the HETT. Attach additional pages if necessary.

At the end of each shift, please submit the Operator’s Log to LCpl Mayfair at VMGR-352.

3.3 Instructions for Completing the Monthly Maintenance and Repair Log

The Monthly Maintenance and Repair Log should be completed once per month during the evaluation period. The manufacturer recommends three types of maintenance inspections: weekly, periodic, and safety. Weekly inspections should be performed after every 40 hours of operating time or once per week, whichever comes first. Periodic inspections should be performed every 480 hours of operating time or every three months, whichever comes first. Safety inspections should be performed after every 1,000 hours of operating time or once each year, whichever comes first.

Enter the month in the space provided. Questions 1 through 4 relate to weekly, periodic, and safety inspections performed on the HETT. For question 1, circle the appropriate answer (Yes or No) for each type of inspection. If yes, respond to questions 2 through 4 in that column; if no, leave the remainder of that column blank.

Questions 5 through 9 relate to repairs performed on the HETT. For question 5, circle the appropriate answer (Yes or No). If yes, respond to questions 6 through 9; if no, skip questions 6 through 9.

If the HETT requires repairs during implementation of this test plan, repairs must be arranged through either Ken Wright (UTRS) or Dennis Derion (NAVAIRLKE). Refer to Section 4.1, Points of Contact, for the appropriate phone numbers. Do **not** contact ISE directly.

If you have any additional comments (either compliments or complaints) regarding the HETT, include them in the space provided under Additional Comments. Attach additional pages if necessary.

4.0 REPORTING

Captain Timothy Sanchez (VMGR-352) has approved the use of these log sheets for this project. As previously described, the Operator's Log will be completed by each operator of the HETT, and the Monthly Maintenance and Repair Log will be completed once per month by LCpl Mayfair. Data will be collected for approximately 6 months at MCAS Miramar and an additional 6 months at NAS Brunswick. During the evaluation period, the data sheets will be faxed to Ken Wright (see Section 4.1, Points of Contact, for the fax number) monthly, at a minimum. The final report will include information on the system's safety, overall performance, cost-effectiveness, and ability to interface with site operations.

4.1 Points of Contact

If any questions arise or repairs are necessary during the evaluation period, contact either of the following individuals:

POC	Affiliation	Phone No.	Fax No.
Ken Wright	UTRS, Cherry Hill, NJ	(856) 667-6770	(856) 667-7586
Denny Derion	NAVAIR LKE, Code 4.8.2.2, Lakehurst, NJ	(732) 323-7120 DSN: 624	(732) 323-4917

Please note that due to contract requirements, VMGR-352 / MCAS Miramar personnel should ***not*** directly contact ISE unless there is an emergency. All communication with the vendor should be directed through UTRS.

HYBRID ELECTRIC TOW TRACTOR OPERATOR'S LOG

Table 1: General Information					
Squadron:				APU Hourmeter	Fuel Level
Date:			At Start of Shift		
Temperatures (high, low):			At End of Shift		
Charging Mode:	<input type="checkbox"/> APU Charging <input type="checkbox"/> Overnight Charging <input type="checkbox"/> Opportunity Charging		Total Quantity of Fuel Added During Shift		

Odometer at Start of Move	Time at Start of Move	Type of Aircraft/SE Towed	Time at Start of Tow	Time at End of Tow	Odometer at End of Move	Time at End of Move	Steering Modes Used	Operator's Initials
							<input type="checkbox"/> 2W <input type="checkbox"/> 4W <input type="checkbox"/> C	
							<input type="checkbox"/> 2W <input type="checkbox"/> 4W <input type="checkbox"/> C	
							<input type="checkbox"/> 2W <input type="checkbox"/> 4W <input type="checkbox"/> C	
							<input type="checkbox"/> 2W <input type="checkbox"/> 4W <input type="checkbox"/> C	
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							<input type="checkbox"/> 2W <input type="checkbox"/> 4W <input type="checkbox"/> C	

Note: If towing a single aircraft, one move includes transit to the aircraft, towing, and transit back to the starting point. If towing multiple aircraft, one move is complete when the HETT detaches from the first aircraft to begin transit to the second aircraft.

Comments: _____

At the end of each shift, submit this log to LCpl Mayfair.
Please fax all completed Operator's Logs to Ken Wright at (856) 667-7586 once a month.

HYBRID ELECTRIC TOW TRACTOR MONTHLY MAINTENANCE AND REPAIR LOG

Month: _____

Scheduled Inspections

	Weekly (40 hours)	Periodic (480 hours)	Safety (1,000 hours)
1. Inspection performed?	Yes No	Yes No	Yes No
2. Number of times inspection performed this month?			
3. Total time spent performing inspections this month?			
4. Deficiencies noted during inspection			

Repairs (If the HETT requires repairs, contact Ken Wright at (856) 667-6770, x125.)

5. Were any repairs required this month? Yes No
(If yes, please answer the following questions. If no, skip the following questions.)
6. Provide a detailed description of the problem: _____

7. Identify all parts required to complete the repairs: _____

8. How long did it take to perform the repairs?: _____
9. How long was the HETT out of service due to this problem?: _____

Additional Comments

When complete, submit this log to LCpl Mayfair.

Fax this log and all Operator's Logs to Ken Wright at (856) 667-7586 once per month.